PB86-157773

Reproductive Outcomes in Women Exposed to Solvents in 36 Reinforced Plastics Companies 1. Menstrual Dysfunction

Cincinnati Univ., OH

Prepared for

Health Effects Research Lab.
Research Triangle Park, NC

1985

U.S. Department of Commerce
National Technical Information Service
NTIS.

TECHNICAL REPORT DATA
(Please read instructions on the reverse before comr

PB86-157773

1. REPORT NO. EPA/600/J-85/269	2.
4. TITLE AND SUBTITLE REPRODUCTIVE OUTCOMES IN WOMEN EXPOSED TO SOLVENTS IN 36 REINFORCED PLASTICS COMPANIES. 1. MENSTRUAL DYSFUNCTION (Journal Version)	5. REPORT DATE 1985 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Grace K. Lemasters, Ann Hagen, and Steven J. Samuels*	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Dept. of Environmental Health, University of Cincinnati, College of Medicine, Cincinnati, OH and *Depts. of Internal Medicine and Obstetrics and Gynecology, University of California, Berkeley, CA	10. PROGRAM ELEMENT NO. CBMC1A 11. CONTRACT/GRANT NO. R806669
12. SPONSORING AGENCY NAME AND ADDRESS Health Effects Research Laboratory (HERL) Office of Research and Development (ORD) U.S. Environmental Protection Agency (USEPA) Research Triangle Park, North Carolina 27711	13. TYPE OF REPORT AND PERIOD COVERED Journal 14. SPONSORING AGENCY CODE EPA-600/11

15. SUPPLEMENTARY NOTES
P.O. Charlotte Cottrill, CSSB/TMD/HERL/USEPA (CI)
Citation: Journal of Occupational Medicine, Vol. 27, No. 7, pp 490-494, July 1985

16. ABSTRACT

Recent studies have suggested that exposure to styrene monomer and other solvents is associated with menstrual disturbances. This is the first U.S. study to evaluate the effects of exposure to styrene on dysmenorrhea, intermenstrual bleeding, secondary amenorrhea, menstrual blood clots, and hypermenorrhea. A comprehensive questionnaire was administered to 1,535 blue-collar workers. Multiple logistic regression analyses did not reveal a positive association between styrene exposure and any menstrual abnormality. Risk factors associated with menstrual disturbances included chronic illness with secondary amenorrhea ($p \leq .005$), nulliparity with both decreased blood clots ($p \leq .005$) and hypermenorrhea ($p \leq .001$), smoking with blood clots ($p \leq .005$), and age with hypermenorrhea ($p \leq .001$). The overall prevalences of menstrual disorders were 14% for dysmenorrhea, 16% for intermenstrual bleeding, 7% for secondary amenorrhea, 40% for menstrual blood clots, and 37% for hypermenorrhea.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS (This Report) Unclassified	21. NO. OF PAGES 7
	20. SECURITY CLASS (This page) Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

EPA/600/J-85/269
JOURNAL ARTICLE

Reproductive Outcomes in Women Exposed to Solvents in 36 Reinforced Plastics Companies

I. Menstrual Dysfunction

Grace K. Lemasters, Ph.D.; Ann Hagen, M.D.; and Steven J. Samuels, Ph.D.

Recent studies have suggested that exposure to styrene monomer and other solvents is associated with menstrual disturbances. This is the first U.S. study to evaluate the effects of exposure to styrene on dysmenorrhea, intermenstrual bleeding, secondary amenorrhea, menstrual blood clots, and hypermenorrhea. A comprehensive questionnaire was administered to 1,535 blue-collar workers. Multiple logistic regression analyses did not reveal a positive association between styrene exposure and any menstrual abnormality. Risk factors associated with menstrual disturbances included chronic illness with secondary amenorrhea ($p \leq .005$), nulliparity with both decreased blood clots ($p \leq .005$) and hypermenorrhea ($p \leq .001$), smoking with blood clots ($p \leq .005$), and age with hypermenorrhea ($p \leq .001$). The overall prevalences of menstrual disorders were 14% for dysmenorrhea, 16% for intermenstrual bleeding, 7% for secondary amenorrhea, 40% for menstrual blood clots, and 31% for hypermenorrhea.

A variety of physiological, psychological, and sociological factors have been linked with menstrual disorders. These factors include age,[1] extreme weight ranges,[2-9] parity,[1,10] liver diseases,[11] thyroid abnormalities,[6,7,12] use of intrauterine devices,[13-16] stress,[3,5,8,17] exercise,[2,4,9] and marital status.[1] Exposure to exogenous agents, such as steroids,[3] methaqualone,[18] oral contraceptives,[1,19] and alcohol,[1,20] is associated with amenorrhea, hypermenorrhea, or dysmenorrhea.

Although women comprise about half of the work force, there have been only limited reports on the impact of the occupational environment on menses.[21-37] Worker exposures to a variety of solvents such as benzene, toluene, and xylene have been linked to menstrual disorders.[34-36] Recently, animal and human data have suggested that exposure to another widely used solvent, styrene monomer ($C_6H_5CH = CH_2$), may be associated with menstrual disturbances.[37,38] An experimental study evaluating exposure of rats to concentrations of styrene at 5 or 50 mg/m³ revealed prolongation of the estrous period.[38] Zlobina et al[37] reported that female workers exposed to styrene experienced irregular cycles and hypermenorrhea.

The purpose of this study was to determine the extent of adverse menstrual disorders, including amenorrhea, dysmenorrhea, and hypermenorrhea, in females employed in the reinforced plastics industry (RPI). Exposures in this industry are primarily to styrene monomer and other solvents such as methyl ethyl ketone and acetone. This study is the first in the United States to evaluate the effects of these exposures on the menstrual cycle. This report is the first from a large study examining several reproductive outcomes associated with exposures to styrene.

Methods

Recruitment of Companies — Selection of reinforced plastic companies was based on the type of process, the product, the number of English-speaking employees, and pragmatic considerations of travel costs. Potential study companies were identified using several membership directories and buyers' guides.[39-41] Of the 120 eligible open and press molding companies contacted, 36 agreed to par-

From the Department of Environmental Health, University of Cincinnati, College of Medicine (Drs. Lemasters and Hagen); and the Departments of Internal Medicine and Obstetrics and Gynecology, University of California, Davis (Dr. Samuels).

Address correspondence to Department of Environmental Health, University of Cincinnati, College of Medicine, Mail Location 182, Cincinnati, OH 45267 (Dr. Lemasters).

This research was supported by grant 806669 from the Environmental Protection Agency.

NTIS is authorized to reproduce and sell this report. Permission for further reproduction must be obtained from the copyright owner.

Journal of Occupational Medicine,
27(7):490-494, July 1985

Table 1 — Demographic Characteristics of Exposed and Nonexposed Women		
	Exposed Women (N=174)	Unexposed Women (N=449)
Mean age, yrs	30.8	30.1
Mean years of education	11.2	12.6
Mean parity	2.4	2.1
% White	86.8	90.2
Family income, %		
<$15,000	42.5	40.5
$15,001-$25,000	37.9	36.3
>$25,000	19.0	20.5
Unknown	0.6	2.7

ticipate. Reasons for nonparticipation among the remaining 84 companies were as follows: no longer in business (13), never reached by telephone (19), personnel records destroyed in fire in 1979 (one), and refusal (51).

Study Population — The study group was comprised of women who met the following criteria: (1) age under 36 at time of hire, (2) employment for a minimum of six months between Jan. 1, 1974, and Feb. 1, 1981, and (3) a current or a previous marriage. A total of 2,177 women workers met these eligibility requirements; 1,535 (70.5%) were interviewed by telephone. Of the 642 employees not interviewed, 94 refused, 253 were not located, 285 either had no telephone or had an unlisted number, and 10 were deceased.

Analyses of menstrual disorders included data from 623 of the 1,535 women, 174 exposed and 449 unexposed employees. Unexposed workers were comprised of office workers, unexposed production workers, and women who had not worked in the RPI nine months prior to interview. Of the 912 women excluded from the menstrual analyses, 751 were omitted for conditions that might affect their menses, including use of birth control pills or an intrauterine device; a pregnancy during the preceding year; surgical hysterectomy; primary amenorrhea; current anticoagulant therapy; history of cancer of the uterus, cervix, or ovary; or current age above 39 years. Women who had terminated employment in the RPI industry within the preceding nine months (N = 161) were also excluded to avoid misclassification of exposure status due to incomplete clearance of the compound. As shown in Table 1, the exposed and unexposed groups were comparable with respect to age, parity, racial status, and family income, but the exposed subjects were somewhat less well educated.

Table 2 — Reported Menstrual Disorders, Unemployed vs Employed Women*				
Reported Menstrual Abnormality	Unemployed, % Abnormal (N=156)	Employed, % Abnormal (N=293)	χ^2	p
Severe dysmenorrhea	14.7	14.0	0.05	.83
Intermenstrual bleeding	14.7	16.4	0.21	.65
Secondary amenorrhea	8.3	7.9	0.03	.86
Menstrual blood clots	36.5	39.6	0.40	.53
Hypermenorrhea	32.7	28.3	0.93	.34

* Exposed RPI women excluded from this analysis to evaluate the possible independent affect of employment

Questionnaire

An extensive standardized reproductive and work history questionnaire was adapted from one developed by the National Institute for Occupational Safety and Health. Because of noted problems in recall of menstrual histories,[42] the survey instrument focused only on menstrual function for the preceding six months (specific questions available on request). The problems pursued included prolonged amenorrhea (six months without a period), severe dysmenorrhea (confined to bed with painful periods), new-onset amenorrhea (periods missed for two to six months), blood clots, and hypermenorrhea (heavier flow than usual).

The questionnaire was administered by telephone using trained professional interviewers. Telephone interviews were chosen in preference to in-person or on-site interviews because (1) half of the study population were former employees, (2) the companies were located in 14 states, (3) experience has shown that sensitive and complex data can be gathered by telephone, (4) respondents who have difficulty understanding questions over the telephone are also likely to have similar problems with in-person interviews, and (5) telephone interviews from a central location allow for greater quality control.[43,44] Silent-call-monitoring was used to determine if the interviews were conducted properly. To minimize bias, interview assignment of exposed and unexposed workers was random and menstrual data were collected prior to exposure information.

Estimation of Exposure

A total of 36 reinforced plastics companies involved in open molding (n=27), press molding (n=4), or a combi-

Table 3 — Reported Menstrual Disorders, Exposed vs Unexposed Women				
Reported Menstrual Abnormality	Exposed, % normal (N=174)	Unexposed, % abnormal (N=449)	χ^2	p
Severe dysmenorrhea	12.6	14.3	0.27	.60
Intermenstrual bleeding	17.8	15.8	0.37	.54
Secondary amenorrhea	4.0	8.0	3.11	.08
Menstrual blood clots	42.5	38.5	0.84	.36
Hypermenorrhea	33.3	29.8	0.72	.40

Table 4 — Logistic Regression Equations for the Effect of Styrene Exposure on Menstrual Disorders*

Outcome	Intercept	Exposure (0 = No, 1 = yes)	Age/10	(Age/10)²	Chronic Illness	Marital Status	Smoking Status	Parity
Severe dysmenorrhea	-2.95 (0.76)	-0.14 (0.27)	1.79 (1.26)	-0.82 (0.52)	0.37 (0.38)	0.44† (0.26)	0.27 (0.24)	0.31 (0.32)
Intermenstrual bleeding	-2.43 (0.74)	0.09 (0.24)	1.30 (1.21)	-0.57 (0.49)	-0.13 (0.41)	0.27 (0.24)	0.32 (0.22)	-0.59 (0.37)
Secondary amenorrhea	-1.80 (0.87)	-0.65 (0.43)	0.07 (1.58)	-0.65 (0.73)	1.32‡ (0.43)	-0.12 (0.39)	0.07 (0.33)	-0.01 (0.42)
Menstrual blood clots	-1.09 (0.53)	0.09 (0.19)	0.77 (0.87)	-0.27 (0.35)	0.45 (0.29)	0.18 (0.19)	0.35§ (0.17)	0.59§ (0.26)
Hypermenorrhea	-1.48 (0.58)	0.12 (0.20)	1.58 (0.97)	-0.80§ (0.39)	0.01 (0.32)	0.22 (0.20)	0.27 (0.18)	-0.99‡ (0.30)

† P≤.10
§ P≤.05
‡ P≤.005
* Shown are the coefficients and, in parenthesis, standard errors

nation of the two processes (n=5) participated in the study. Open molding processes generally expose the worker to higher levels of styrene than does press molding.[45,46] After a company agreed to participate, the principal investigator visited each to gather pertinent industrial hygiene information, personnel information for cohort identification, and work histories. Details of exposure assessment are provided elsewhere.[47]

After examination of the data by product (e.g., boats, tubs, trays), process (open or press), and exposure type (direct hands-on contact or indirect ambient air), there was a clear demarcation between (1) companies performing open mold manufacture of boats, trucks, and car parts and (2) all others. Workers at these companies performing open molding and having direct contact with styrene had an estimated weighted mean exposure of 52 ppm. All other open mold process workers (those directly exposed in the manufacture of tanks, pipes, panels, and pans and all those indirectly exposed) and all press molding jobs had an estimated weighted mean exposure of 13 ppm.[47] Limited data were available for other solvent exposures. Therefore, estimation of exposure was based on styrene levels.

Analysis — Due to the number of risk factors with known association with menstrual disorders, multiple logistic analyses were performed. Risk factors (main effects) identified included (1) age, (2) age squared (to control for a potential nonlinear trend), (3) marital status, (4) parity, (5) the presence of a chronic disease, e.g., thyroid disorders, diabetes, stroke, arthritis, tuberculosis, severe renal disorders, systemic lupus erythematosus, sarcoidosis, and Crohn's disease, and (6) smoking status.

The effect of styrene on menses was analyzed using several exposure models. For the first analysis, workers were assigned, on the basis of current jobs, into either an exposed or an unexposed group. The second exposure model examined the dose response to exposure in the woman's current job by dividing the workers into three ordered exposure categories: no = 0, low = 1 (estimated mean exposure of 13 ppm), and high = 2 (estimated mean exposure of 52 ppm). Next, to assess the impact of exposure and total duration of employment on menses, the length of uninterrupted employment in the RPI was multiplied by the mean exposure level to obtain a total ppm-days value. Finally, exposure was tested using a dummy variable model comparing no exposure with low exposure (1 to 14,000 ppm-days) and no exposure with high exposure (>14,000 ppm-days). These models were proposed to evaluate the consistency of results with different characterization of exposure.

Results

Of the 174 exposed workers, 123 were in low-exposure jobs and 51 were in high-exposure jobs. Of the 449 unexposed women, 117 were in unexposed jobs in the styrene industry, 176 had jobs outside the plastics industry, and 156 were currently unemployed.

The possible independent effect of employment on menses was evaluated first. All women currently employed in an exposed job in the RPI were omitted and employed women were compared with unemployed women. No significant difference was found between employed and unemployed women in reports of menstrual disorders (Table 2). The percentages of employed and unemployed women reporting a menstrual disorder were approximately 8% for secondary amenorrhea, 14% to 16% for dysmenorrhea and intermenstrual bleeding, 28% to 33% for hypermenorrhea, and 37% to 40% for menstrual blood clots. In the remaining analyses the employed and unemployed workers were combined.

Chi-square statistics showed that there were no differences between the exposed and unexposed groups in reports of severe dysmenorrhea, intermenstrual bleeding, secondary amenorrhea, menstrual blood clots, and hypermenorrhea (Table 3).

Multiple logistic regression analysis showed that exposure to styrene was not associated significantly with menstrual disorders in any exposure model. The exposed/unexposed comparison is shown in Table 4. Other risk factors that were found to have a significant association with menstrual dysfunction included having a chronic illness on secondary amenorrhea ($p \leq .005$); age ($p \leq .10$), age² ($p \leq .05$), and nulliparity ($p \leq .001$) on hypermenorrhea; and

smoking ($p \leq .05$) and nulliparity ($p \leq .05$) on an increase in menstrual blood clots. The overall prevalences of menstrual disorders for the combined groups were 14% for dysmenorrhea, 16% for intermenstrual bleeding, 7% for secondary amenorrhea, 40% for menstrual blood clots, and 31% for hypermenorrhea.

Discussion

Findings from this study suggest that exposure to styrene and other solvents in the reinforced plastics industry is not associated with a significant increase in any menstrual disorder. Findings from other studies have suggested that solvents in general, including styrene, may have an effect on menses.[31,33,34,36,37] However, there are major problems with these solvent studies, including the lack of comparison between exposed subjects and controls (if used) for similarity in important risk factors such as age and parity and control for significant risk factors such as medical conditions, contraceptive usage, smoking, or alcohol use.

Interest in the possible effect of styrene exposure on menses was generated following a report by Zlobina et al.[37] They noted that 32.7% of workers (n = 36/110) with relatively low exposure (close to maximum acceptable concentration levels) reported disorders in cycle rhythm and hypermenorrhea compared with 9.1% (n = 21/231) of the control subjects. While the groups were comparable on education, income, and parity, potentially confounding factors such as contraceptive methods, recent pregnancies, medication usage, and chronic illnesses were not addressed.[37]

Styrene exposure levels for the majority of workers were generally under 30 ppm. Therefore, this study does not fully address the possible effects on workers with higher exposures. The study had an 85% chance using a one-tailed 0.05 test of detecting a doubling of the odds for secondary amenorrhea. Power for all remaining outcomes was above 90%. Although this study had good power, to obtain a total eligible sample of 623 women, a population of 2½ times that number was required.

This study provides normative data for the general population. Of the 623 interviewed women, 14% of the sample reported severe dysmenorrhea (defined as being confined to bed with painful periods). In the Sheppard Foundation study[18] of 2,343 women, 80% reported pain with their period. The Sheppard study, however, asked about pain with no qualification.

Sixteen percent of the women in this study reported intermenstrual bleeeding. No data for this disorder currently exist in the literature. In terms of secondary amenorrhea, Singh[8] reports that approximately 2.8% in the population report missed periods for three months or more, compared with 7% in this study. Finally, 40% and 31% reported abnormalities in their menses associated with either blood clots or heavier flow, respectively. Of women requesting gynecologic consultations at a student health center, only 8% reported hypermenorrhea[8]. It is possible that most women are not seeking medical attention for this problem.

Some observations can also be made regarding other risk factors examined in this study. Chronic illness, as expected, had the strongest association with secondary amenorrhea. Nulliparity was significantly associated with decreased menstrual blood clots and menorrhagia. In the literature, nulliparity has been associated with increases in amenorrhea and dysmenorrhea.[1,10] The hypothesis for the association of nulliparity with these types of disorders is that these women have not proven, through childbirth, that their hormonal system is intact[2].

Smoking was found to be associated with increases in menstrual blood clots. Smoking has also been linked with menstrual disorders in other studies.[1,10] This finding, however, might be associated with another factor, that is, smokers weigh less on the average and weight has been linked with menstrual disorders.[49]

A final interesting facet to this study was the similar prevalence of menstrual disorders in both working and nonworking populations. There seems to be no "healthy worker" effect when menstrual abnormalities are considered, i.e., women who work having fewer menstrual problems.

Acknowledgments

Vicki Hertzberg, Ph.D., and Harold Zenick, Ph.D., reviewed the manuscript, and Marilyn Clark and Crystal Solimine prepared this manuscript.

References

1. Wood C, Larsen L, Williams R: Social and psychological factors in relation to premenstrual tension and menstrual pain. *Aust NZ J Obstet Gynaecol* 19:111–115, 1979.
2. Baker ER: Menstrual dysfunction and hormonal status in athletic women: A review. *Fertil Steril* 36:691–696, 1981.
3. Comerci GD: Symptoms associated with menstruation. *Pediatr Clin North Am* 29:177–200, 1982.
4. Dale E, Gerlach DH, Wilhite AL: Menstrual dysfunction in distance runners. *Obstet Gynecol* 54:47–53, 1979.
5. Fries H, Nillius SJ, Pettersson F: Epidemiology of secondary amenorrhea: II. A retrospective evaluation of etiology with respect to psychogenic factors and weight loss. *Am J Obstet Gynecol* 118:473–479, 1974.
6. McDonough PG, Gambrell RD: The adolescent gynecologic patient and her problems. *Clin Obstet Gynecol* 22:491–507, 1979.
7. McFarland KF: Amenorrhea. *Am Fam Physician* 22:95–101, 1980.
8. Singh KB: Menstrual disorders in college students. *Am J Obstet Gynecol* 140:299–302, 1981.
9. Wentz AC: Body weight and amenorrhea. *Obstet Gynecol* 56:482–487, 1980.
10. Pettersson F, Fries H, Nillius SJ: Epidemiology of secondary amenorrhea: I. Incidence and prevalence rates. *Am J Obstet Gynecol* 117:80–86, 1973.
11. Green P, Rubin L: Amenorrhea as a manifestation of chronic liver disease. *Am J Obstet Gynecol* 78:141–146, 1959.
12. Goldsmith RE, Sturgis SH, Lerman J, et al: The menstrual pattern in thyroid disease. *J Clin Endocrinol Metabol* 12:846–855, 1952.
13. Fayez JA: Dysfunctional uterine bleeding. *Am Fam Physician* 25:109–115, 1982.
14. Klein SM, Garcia CR: Asherman's syndrome: A critique and current review. *Fertil Steril* 24:722–735, 1973.
15. Bonnar J, Kasonde K, Haddon M, et al: Fibrolytic activity in utero and bleeding complications with intrauterine contraceptive devices. *Br J Obstet Gynaecol* 83:160–164, 1976.
16. Dawood MY: Dysmenorrhea. Baltimore: William & Wilkens Co. 1981, pp 157–159.
17. Skandhan KP, Pandya AK, Skandhan S, et al: Academic examination stress versus menstrual cycle. *Panminerva Med* 23:47–49, 1981.
18. Kessel A, Marriot PF, Graves GD: Methaqualone: Efficacy as a hypnotic and side effects. *Med J Aust* 1:531–534, 1971.
19. Harrington JM, Rivera RO, Lowry LK: Occupational exposure to synthetic estrogens: The need to establish safety standards. *Am Ind Hyg Assoc J* 39:139–143, 1978.

20. Ryback RS: Chronic alcohol consumption and menstruation. *JAMA* 238:2143, 1977.

21. Kuznetova LS: The effects of the various operations in the manufacture of superphosphate on the sex organs of female workers, abstracted. *Gig Tr Prof Zabol* 13:21–25, 1969.

22. Koppich A: Influence of working conditions in the textile industry upon the health of women, abstracted. *Industria Textila* 23:369–372, 1972.

23. Ferreo GP, Gueli M: Absenteeism due to sickness among workers in the cotton industry, abstracted. *Med Lav* 59:793–797, 1968.

24. Griesmer RA, Ulsamer AG, Arcos JC, et al: Report of the federal panel on formaldehyde. *Environ Health Perspect* 43:139–168, 1982.

25. Harrington JM, Stein GF, Rivera RO, et al: The occupational hazards of formulating oral contraceptives — a survey of plant employees. *Arch Environ Health* 33:12–15, 1978.

26. Agaponova ED, Markov VA, Siskina LF, et al: Effect of androgens on women engaged in their production. *Gig Tr Prof Zabol* 12:24–27, 1973.

27. Ehrhardt W: Experiences with the employment of women exposed to carbon disulfide, abstracted in Brieger H, Teisinger J (Eds.): Toxicology of Carbon Disulfide. Amsterdam: Excerpta Medica Foundation 1967 p 240.

28. Smith AR: Chronic benzol poisoning among women industrial workers: A study of the women exposed to benzol fumes in six factories. *J Ind Hyg* 10:73–93, 1928.

29. Lotis VM, Solovieva IP, Tartakovskaya LY: The effect of general vibrations on the female sexual apparatus, abstracted. *Vopr Okhrany Materinstva I Detstva* 10:62–66, 1962.

30. Livke TN, Nosko AM, Noshkov NS: A proposal of chronic intoxication with croton aldehyde, abstracted. *Vrach Delo* 2:96–98, 1969.

31. Panova Z: Menstrual and reproductive functions and gynaecological morbidity in women occupationally exposed to petrol. *Letopisi Na Higienno-Epidemiologicnata Sluzba* 20:53–56, 1976.

32. Iglesias R, Terres A, Chavarria A: Disorders of the menstrual cycle in airline stewardesses. *Aviat Space Environ Med* 51:518–520, 1980.

33. Gesev G: Changes in the menstrual cycle of women occupationally exposed to trinitrotoluene. Parva Nacionalna Koferenciza Na Aspirantite. Medicina I Fizkultura. Sofia. April, 1967, pp 259–262.

34. Michon S: Connection between aromatic hydrocarbons and menstrual disorders analyzed, abstracted. *Polski Tygodnik Lekstvi* 20:1648–1649, 1965.

35. Butarewicz, L, Gosk S Gluszczoma M: Examination of the health of female workers in the leather industry, especially from the gynaecological viewpoint, abstracted. *Med Pr* 20:137–140, 1969.

36. Syrovadko ON, Skormin VF, Pronkova EN, et al: Effect of working conditions on the health and some specific functions in female workers exposed to white spirit. *Gig Tr Prof Zabol* 16:5–8, 1973.

37. Zlobina NS, Izyumova AS, Ragulie NY: The effect of low styrene concentrations on the specific functions of the female organism. *Gig Tr Prof Zabol* 18:21–25, 1975.

38. Izyumova AS: Action of small concentrations of styrene on the sexual function of albino rats. *Gig Sanit* 37:29–30, 1972.

39. Thomas Register of American Manufacturers and Thomas Register Catalogue File 69:5–6, 1979.

40. The Boating Industry Marine Buyer's Guide. New York: Boating Industry Magazine, 41(13), 1978–1979.

41. 1979 Membership Directory and Buyer's Guide. New York: Society of the Plastics Industry Inc.; 1978.

42. Bean JA, Leeper JD, Wallace RB, et al: Variation in the reporting of menstrual disorders. *Am J Epidemiol* 109:181–184, 1979.

43. Mooney HW, Pollack BR, Corsa L: Use of telephone interviewing to study reproduction. *Public Health Rep* 83:1049–1060, 1968.

44. Frey JH: Survey Research by Telephone. Beverly Hills: Sage Library of Social Research, 1983, vol. 150.

45. Schumacher RL, Breysse PA, Carolyn WR, et al: Styrene exposure in the fiberglass fabrication industry in Washington state. *Am Ind Hyg Assoc J* 42:143–149, 1981.

46. Ikeda M, Koizumi A, Miyasaka M, et al: Styrene exposure and biologic monitoring in FRP boat production plants. *Int Arch Occup Environ Health* 49:325–339, 1982.

47. Lemasters GK, Carson A, Samuels SJ: Occupational styrene exposure for twelve product categories in the reinforced plastic industry. *Am Ind Hyg Assoc J*, in press.

48. Wood C, Larsen L, Williams R: Menstrual characteristics of 2,343 women attending the Sheppard Foundation. *Aust NZ J Obstet Gynaecol* 19:107–110, 1979.

49. Sloss EM, Frerichs RR: Smoking and menstrual disorders. *Int J Epidemiol* 12:107–109, 1983.

Hard Choices in Medical Care

The spread of effective limits on hospital spending would create a wholly new environment for health care providers and administrators. They would be forced to establish priorities and then buy only the most cost-effective new equipment. They would have to decide which new services they could afford and establish criteria for determining which patients to admit and which to reject. And they would have to determine which methods of diagnosis or therapy are too costly to provide to admitted patients.

Such choices are now uncommon, except for the poor, many of whom have long had only limited access to high-quality care. To many, the balancing of costs and medical benefits seems obscene. Yet such choices cannot be avoided, either explicitly or implicitly. When airports install less-than-the-best traffic-control devices, the probability of a fatal crash increases. When highways are not divided or automobiles are not made safer, the number of likely highway fatalities rises. In each case, a calculation is made that the price of added safety is too high. That such choices seem imminent for hospital care is, perhaps, less surprising than the fact that they have been deferred for so long.

—From "Health Care Costs: The Social Tradeoffs" by W.B. Schwartz and H.J. Aaron in *Issues in Science and Technology*, Winter, 1985. Published by the National Academy of Sciences, Washington, D.C.

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

This article documents research that was conducted under the auspices of the U.S. Environmental Protection Agency (USEPA). As an arm of the government, the USEPA has a paid up, non-exclusive, irrevocable, worldwide license to reproduce, prepare derivative works, and distribute to the public all of the material contained herein, and to grant others acting on its behalf the right to do so. The USEPA grants to the National Technical Information Service, Department of Commerce, the right to act as its agent in the distribution of this material.